Johannes Gutenberg-University Mainz

Institute for Physics

Lecture

Introduction to Polymer Physics I (3 SWS+ exercises)

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1. Introduction

1.1 What is a polymer?
1.2 Length scales
1.3 Materials
1.4 Architectures: constitution & configuration
1.5 Polymers vs. monomers
1.6 Polymers vs. other materials

2. Synthesis & Distributions

2.1 Radical polymerization
2.2 (An)ionic polymerization
2.3 Polycondensation
2.4 Metallocene catalysts
2.5 Kinetics
2.6 Molecular weight distributions & averages
2.7 Molecular weight determination: GPC, HPLC, MALDI-TOF (see models 4.4; 5.1.5.)

3. Chain Models

3.1 Definitions: bond angles and -lengths, conformation etc.
3.2 Characteristic quantities: radius of gyration, end-to-end radius, persistence length etc.
3.3 Freely rotating chain
3.4 Freely jointed chain
3.5 Gaussian chain
3.6 Worm-like chain
3.7 RIS model

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4. Polymer Solutions & Mixtures

4.1 Excluded volume interaction & Flory theory
4.2 Concentration regions & overlap concentration
4.3 Flory-Huggins theory for small-molecule und polymer mixtures
4.4 Osmotic pressure & membrane osmometry
4.5 Good and bad solvent, θ conditions
4.6 Phase diagrams for polymer solutions and -mixtures: Gibbs stability criterion, bimodal, spinodal, critical point, miscibility gap etc.
4.7 Flory-Krigbaum theory: definition θ temperature
4.8 Phase separation mechanisms: spinodal and bimodal decomposition

5. Scattering Methods

5.1 Static Scattering

5.1.1 Definitions: energy transfer, scattering vector, current density, total and partial differential scattering cross section
5.1.2 Quantum mechanical formulation of the scattering problem
5.1.3 Comparison between scattering probes + methods: neutrons, visible light and x-rays and pair correlation function
5.1.4 Form factor and structure factor, dependency on density profile
5.1.5 Determination of molecular weight & influence of polydispersity and compressibility/ osmotic pressure, Zimm plot
5.1.6 Connection between I(0) a
5.1.7 Guinier approximation
5.1.8 Length scales vs. q regions Examples for static s
5.1.9 Scattering spectra: Gaussian chain, sphere form factor, fractal structures, ordered structures

5.2 Dynamic Scattering

5.2.1 Definition: double-differential scattering cross section
5.2.2 Van Hove equations and correlation functions: pair- and self correlation function
5.2.3 Comparison between scattering probes + methods: neutrons, visible light and x-rays
5.2.4 Examples for dynamic scattering spectra: oscillation, vibration, diffusion, relaxation

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